

ATTACHMENT B

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

1. (previously presented) A reciprocating engine operating between a minimum speed of rotation N_{min} and a maximum speed N_{max} comprising:

a turbocharging unit which:

- supplies an intake manifold of the engine with compressed air via a cooler;
- is supplied with gas by an exhaust manifold of the engine at the exhaust temperature; and
- has a turbine inlet pressure substantially equal to a compressor discharge pressure; in such a way that at constant air temperature and with a fixed geometry, the turbocharging unit delivers a substantially constant volume of cooled air V_c when the compressor discharge pressure varies,

and that the volume V_c is substantially proportional to a turbine inlet section offered to hot gases,

wherein the turbine inlet pressure is maintained substantially equal to the compressor discharge pressure by a EGR bypass provided between the intake manifold and an exhaust manifold dimensioned to transfer a flow of exhaust gas to the intake manifold without significant loss of pressure,

and wherein the volume of air V_c is less than the volume drawn in by the engine at the speed N_{max} such that a flow of hot gases is drawn in again by the engine via the EGR bypass above a turbocharging adaptation speed N_a , where the volume drawn in is equal to volume V_c , and a flow of air is deflected towards the turbine below the adaptation speed N_a .

2. (previously presented) A reciprocating engine as claimed in Claim 1, wherein the EGR bypass has an EGR valve to increase the turbine inlet pressure above the compressor discharge pressure.

3. (previously presented) A reciprocating engine as claimed in Claim 1, wherein the turbocharging unit has an intake valve situated on a compressed air discharge conduit to increase the compressor discharge pressure above the turbine inlet pressure.
4. (previously presented) A reciprocating engine as claimed in Claim 1, wherein the EGR bypass has a gas cooler adjustable to cool gas up to a temperature close to that of fresh air.
5. (previously presented) A reciprocating engine as claimed in Claim 4, wherein the adjustment of the temperature is effected by controlling a bypass of the cooler.
6. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 4, wherein the EGR bypass temperature is controlled to create the desired excess of air for the combustion in the engine.
7. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 4, wherein the EGR bypass temperature is controlled so that a mass of recycled gases remains substantially equal to a mass of the fresh air up to the speed at which this temperature returns to the exhaust temperature, the recycled mass becoming greater than the mass of the fresh air above this speed.
8. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 5, wherein the gas cooler is totally bypassed when the engine does not deliver propulsive power.
9. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 8, wherein for cold starting and operating at idling speed, an adjustment of turbine valves and/or a timing of engine valves is adjusted so that the excess of combustion air is minimal for a desired level of depollution.
10. (previously presented) A reciprocating engine as claimed in Claim 1, wherein:

the adaptation speed N_a is substantially equal to $N_{min}/2$ so that a volume of recycled gases is at least equal to that of the fresh air, and

the minimum temperature of the recycled gases is close to the temperature of the fresh air so that a mass of the recycled gases is at least equal to that of the fresh air at the minimum speed used N_{min} in order to depollute during all ranges of use of the engine.

11. (previously presented) A reciprocating engine as claimed in Claim 4, wherein:
the adaptation speed N_a is substantially equal to $N_{min}/2$ so that the volume of recycled gases is at least equal to that of the fresh air, and

the minimum temperature of the recycled gases is close to the temperature of the fresh air so that a mass of the recycled gases is at least equal to that of the fresh air at the minimum speed used N_{min} in order to depollute during all ranges of use of the engine.

12. (currently amended) A reciprocating engine as claimed in Claim 1,
wherein the turbocharging unit has a low-pressure LP turbocharger and a high-pressure HP turbocharger, compressors of which work in series with ~~a cooling of the air between the compressors and an~~ exhaust outlet section S_d which is adjustable between a minimum $S_{d\ min}$ and a maximum $S_{d\ max}$ by one or a combination of the following:

- adjustment of a variable section of a gas distributor of the turbines,
- opening of a bypass between an inlet and an outlet of the turbines,
- passage from a series configuration to a parallel configuration of the turbines,

the turbocharging adaptation speed N_a thus being adjustable, in a continuous or discontinuous manner, between two values $N_{a\ min}$ and $N_{a\ max}$.

13. (previously presented) A reciprocating engine as claimed in Claim 12, wherein the minimum outlet section $S_{d\ min}$ offered to the gases is formed by the two turbines mounted in series at maximum closure.

14. (previously presented) A reciprocating engine as claimed in Claim 13, which operates on a 4-stroke cycle with a fixed timing of associated valves.
15. (previously presented) A reciprocating engine as claimed in Claim 14, wherein the maximum outlet section S_d max offered to the gases is formed by the two turbines which have fixed distributors mounted in parallel, and wherein, in order to pass the turbines from the series configuration to the parallel configuration, the following manoeuvres are carried out successively:
- progressive partial opening of an HP waste gate between the inlet and the outlet of a turbine,
 - progressive and simultaneous partial opening of the HP and an LP waste gates
 - simultaneously and rapidly: total opening of the HP waste gate, total closure of the LP waste gate, putting the outlet of the HP turbine into communication with the outlet of the LP turbine.
16. (previously presented) A reciprocating engine as claimed in Claim 14, wherein the maximum outlet section S_d max offered to the gases is formed by a LP turbine with fixed distributor and a HP turbine with variable distributor mounted in parallel, the HP distributor being fully open, and wherein, in order to pass the turbines from the series configuration to the parallel configuration, the following manoeuvres to be carried out successively:
- progressive opening of a distributor of the HP turbine,
 - progressive partial opening of an LP waste gate,
 - simultaneously and rapidly: total opening of the LP waste gate and putting the outlet of the HP turbine into communication with the outlet of the LP turbine.
17. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 2, wherein, in order to limit a frequency of changing a configuration, the geometry is immobilized for a type of driving which implements a limited power range, and power

thresholds corresponding to each configuration are crossed for manoeuvres of short duration, and

wherein the power thresholds may be crossed:

- by closure of the EGR valve,
- by opening of one or two waste gates,
- by closure of an intake valve.

18. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 3,

wherein, in order to limit a frequency of changing a configuration, the geometry is immobilized for a type of driving which implements a limited power range, and power thresholds corresponding to each configuration are crossed for manoeuvres of short duration, and

wherein the thresholds may be crossed:

- by closure of an EGR valve,
- by opening of one or two waste gates,
- by closure of an intake valve.

19. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 12,

wherein, in order to limit a frequency of changing a configuration, the geometry is immobilized for a type of driving which implements a limited power range, and power thresholds corresponding to each configuration are crossed for manoeuvres of short duration, and

wherein the thresholds may be crossed:

- by closure of the EGR valve,
- by opening of one or two waste gates,
- by closure of an intake valve.

20. (previously presented) A reciprocating engine as claimed in Claim 15, wherein the LP waste gate has a second seat in order simultaneously to effect a closure of the

LP turbine inlet/outlet bypass and putting the HP turbine outlet into communication with the LP turbine outlet.

21. (previously presented) A reciprocating engine as claimed in Claim 15, wherein the two waste gates are concentric and have stops such that simultaneous movements thereof are actuated by one and communicated to the other by the stops.

22. (previously presented) A reciprocating engine as claimed in Claim 14, wherein the maximum outlet section S_d max is formed by two turbines with fully open variable distributors mounted in series, and wherein the distributors are opened simultaneously in order to maintain the intake pressure at a maximum desired value thereof on a full load curve.

23. (previously presented) A reciprocating engine as claimed in Claim 13, wherein a timing of valves is controlled to displace a closure of an associated cylinder between the vicinity of the BDC and the mid-stroke of an associated piston, wherein the maximum outlet section S_d is formed by the HP turbine in series configuration; and wherein the turbines are dimensioned to permit the compressors thereof to reach maximum pressure ratios thereof simultaneously.

24. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 23, wherein a full load curve as a function of the speed is as follows:

from N_{min} to $2 N_{min}$, an intake closure FA passes from the BDC to approximately 90 degrees of a crankshaft after the BDC to maintain a cycle pressure below a desired value thereof, and

a distributor or an HP waste gate is closed;

from $2 N_{min}$ to approximately $3 N_{min}$, the HP distributor or the HP waste gate is open to maintain an intake pressure at a maximum desired value thereof, and

the intake closure FA is maintained at 90 degrees of the crankshaft after the BDC; and

from 3 Nmin to Nmax, a global flow rate of fuel is kept constant to maintain the intake pressure at a limiting value thereof, and

at partial load, a timing of intake closure FA is controlled according to a map stored in an engine control computer.

25. (previously presented) A reciprocating engine as claimed in Claim 13, which operates on the 2-stroke cycle, and wherein:

intake ports are closed by valves,

exhaust ports are closed by valves and communicate with one single exhaust manifold,

an external recycling phase precedes scavenging,

a timing of the valves is controlled to displace a closure of an associated cylinder between the vicinity of the BDC and the mid-stroke of an associated piston,

a maximum outlet section Sd is formed by the HP turbine in series configuration, the turbines are dimensioned to permit associated compressors to reach maximum pressure ratios thereof simultaneously, and

the EGR bypass is one of a check valve or a closable aerodynamic diode.

26. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 25, wherein a full load curve as a function of speed is as follows:

- from Nmin to 2 Nmin, the closure of the cylinder passes from the BDC to approximately 90 degrees of the crankshaft after the BDC to maintain cycle pressure at a desired value thereof,

- a distributor or an HP waste gate is closed,

- from 2 Nmin to approximately 3 Nmin, the HP distributor or the HP waste gate is open to maintain an intake pressure at a maximum desired value thereof,

- an intake closure FA is maintained at 90 degrees of the crankshaft after the BDC,

- from 3 Nmin to Nmax, a global flow rate of fuel is kept constant to maintain the intake pressure at a limiting value thereof; and

wherein, in order to maximize cooled external EGR, depolluted partial loads are effected as follows:

- the cylinder remains closed in the vicinity of the BDC and the turbines remain in closed configuration up to the compressor discharge pressure limit for this timing,
- the turbines are then opened in order to maintain the compressor discharge pressure at a limiting value thereof,
- the aerodynamic diode is used when the external recycling flow stops.

27. (previously presented) A reciprocating engine as claimed in Claim 13, which operates on the 2-stroke cycle,

wherein there are two exhaust ports per cylinder, closed by valves, which communicate respectively with an exhaust manifold connected to the turbine and an exhaust manifold connected to the EGR bypass and/or to the turbine via a controlled distributor valve,

wherein timing of the valve assigned to the EGR bypass is controlled to displace the closure of the cylinder between the vicinity of the BDC and the mid-stroke of an associated piston, wherein:

an external recycling phase precedes the scavenging when the cylinder closes in the vicinity of the BDC and follows the scavenging when the cylinder closes at the mid-stroke of the piston;

the maximum outlet section S_d is formed by the HP turbine in series configuration ;

the turbines are dimensioned to permit the compressors to reach maximum pressure ratios thereof simultaneously; and

the EGR bypass is one of a check valve or a closable aerodynamic diode.

28. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 27, wherein:

the compressor discharge pressure is lower than a limit allowed for the timing,

the distributor valve is in a recycling position,

the cylinder is closed in the vicinity of the BDC,

a distributor or an HP waste gate is closed,
when the pressure reaches the limiting value allowed for this timing, the closure of the cylinder is displaced to the mid-stroke of the piston in order substantially to double the allowed compressor discharge pressure limit,
the distributor valve remains in the recycling position,
the distributor or the HP waste gate remains closed,
the compressor discharge pressure reaches a new limit allowed for this new timing,
the distributor valve blocks the recycling,
the distributor or the HP waste gate opens in order to keep the compressor discharge pressure at a new allowed limit thereof, and
the transition is made by one of progressively in the two directions or rapidly with a hysteresis.

29. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 6, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

30. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 7, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

31. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 8, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

32. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 9, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

33. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 17, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

34. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 18, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled so as to optimize depollution and/or performance according to a map stored in an engine control computer.

35. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 19, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

36. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 24, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

37. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 26, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

38. (previously presented) A method of supplying a reciprocating engine as claimed in Claim 28, wherein:

at full load the variable geometry is controlled to maintain a parameter at a limiting desired value thereof;

at partial load the variable geometry is controlled to optimize depollution and/or performance according to a map stored in an engine control computer.

39. (previously presented) A reciprocating engine as claimed in Claim 1,

including a flat cylinder head bearing valves having faces on a chamber side which are coplanar with the cylinder head and substantially tangent to a cylinder,

wherein an intake pipe or pipes terminate(s) at an oblong nozzle defined by an upper half-cylinder resting on an upper edge of a conical seat and tangent to this seat along a generating line thereof situated in a plane substantially perpendicular to a plane

passing through the axis of the seat and through an axis of the cylinder and through a lower cylinder covering half of a valve head opposite the generating line,

wherein the nozzles are also oriented to create a tangential speed in a same direction, and

wherein angles of the seats are chosen to optimize stratification of a combustive charge.

40. (previously presented) A reciprocating engine as claimed in Claim 1, including a flat cylinder head bearing valves having faces on a chamber side which are coplanar with the cylinder head and substantially tangent to a cylinder, wherein a conical sealing bearing surface of intake valves is extended towards a piston by a cylindrical part having a height slightly greater than a lift of the valves, wherein the conical sealing bearing surfaces of the valves are disposed at a bottom of cylindrical recesses provided in a cylinder head in order to receive cylindrical parts of the valves such that flat lower faces of the valves are in a plane of the cylinder head when the lower faces rest on the associated seats thereof, a clearance between the recesses and the valves being minimal, and

wherein the recesses are provided in the cylinder head and do not go beyond the following boundaries:

- two cylindrical portions concentric with a bore and tangent externally and internally to the cylindrical recess of each valve,
- a conical surface extending a half-seat of the valve delimited by a plane passing through an axis thereof and an axis of the cylinder;

wherein the recesses are also oriented to create a tangential velocity in a same direction, and

wherein an angle of the seats is chosen to optimize a stratification of a combustive charge.

41. (previously presented) A reciprocating engine as Claimed in Claim 39, including two diametrically opposed intake valves.

42. (previously presented) A reciprocating engine as Claimed in Claim 40, including two diametrically opposed intake valves.
43. (previously presented) A reciprocating engine as claimed in Claim 1, wherein:
a fraction of the recycled gases is retained in a cylinder at a closure of the cylinder,
the fresh gases are introduced by directive intake conduits to create a stratification of temperatures and concentrations in a chamber at the combustion top dead centre, and
a fuel is vaporized in the fresh gases.
44. (previously presented) A reciprocating engine as claimed in Claim 43, wherein the fuel is introduced into the fresh air between the compressor and an external EGR mixer.
45. (previously presented) A reciprocating engine as claimed in Claim 43, wherein the fuel is introduced into a mixture between the pure air and an external EGR.
46. (previously presented) A reciprocating engine as claimed in Claim 43, wherein an ignition point is controlled by a timing of valves at the closure of the cylinder.
47. (previously presented) A reciprocating engine as claimed in Claim 43, wherein an ignition point is controlled by a temperature of an external EGR.
48. (previously presented) A reciprocating engine as claimed in Claim 43, wherein a first ignition is controlled electrically or is triggered spontaneously by an injection of the fuel at high pressure at the top dead centre.
49. (previously presented) A reciprocating engine as claimed in Claim 43, wherein:
a working chamber of the gases has a geometry revolving around an axis of the cylinder;

the stratification has a geometry revolving around the axis of the cylinder and created by an orientation of intake ports, and

the temperature of a combustive charge increases between a periphery and the axis so that a self-ignition is propagated from a centre towards a periphery.

50. (previously presented) A reciprocating engine as claimed in Claim 49, wherein a meridian profile of the combustion chamber is chosen to optimize a rate of release of energy by a progressiveness of isothermal surfaces of a reactive load.

51. (previously presented) A reciprocating engine as claimed in Claim 14, wherein the maximum outlet section S_d max offered to the gases is formed by the two turbines which have fixed distributors mounted in parallel, and wherein, in order to pass the turbines from the series configuration to the parallel configuration, the following manoeuvres are carried out simultaneously and with rapidity:

- total opening of an HP waste gate,
- total closing of an LP waste gate,
- putting the outlet of the HP turbine into communication with the outlet of the LP turbine.